LETTERS TO THE EDITOR.

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Osmotic Pressure.

IN the issue of NATURE for May 17 (p. 54) appears a communication by Mr. Whetham in which he attempts to consign actual experimental work on osmotic pressure to the humble *rôle* of showing how far the assumptions made in so-called thermodynamical proofs can be realised experimentally. Among other things, the attempts to apply thermodynamic reasoning to osmotic processes involve the assumption of a membrane which is semi-permeable and which at the same time is quite passive, that is to say, which shows no selective action. Now in my paper (referred to in NATURE for May 3, p. 19) I have demonstrated conclusively by experiment that in actual osmotic processes the selective influence of the membrane is always present, and is the determining factor as to whether osmosis will take place at all, and, if so, in what direction. In studying that paper, the reader will also see that *the more nearly a membrane is semi-permeable in character in practice, the greater is its selective action. In fact, it is the pronounced selective action of the membrane which makes it approximately semi-permeable.* This being the case, it is evident at once that thermodynamic reasoning cannot be applied to actual osmotic processes, and that the experimental work on osmotic pressure does not play that humble *rôle* to which Mr. Whetham would consign it.

Mr. Whetham sees perfect semi-permeable membranes (1) in the surface of growing crystals of pure solvent which separate from a solution when it freezes, and (2) in the free surface of a solution of a non-volatile solute as it evaporates, and states that "from these two facts follows the validity of the thermodynamic relations between osmotic pressure on the one side and freezing point and vapour pressure on the other." Now I must insist that the formation of crystals from a solution, or the concentration of a solution by evaporation, are not osmotic processes. There are, in fact, no actual membranes or septa involved in these processes, and to regard them as "osmotic" in character only causes much confusion, for they have nothing in common with an actual osmotic process, in which a membrane—an additional phase with specific selective action—is always present as a determining factor.

In how far it is allowable to apply thermodynamic reasoning to the evaporation of a solution or the formation of crystals from a solution I shall not attempt to discuss here, for it is quite outside the main subject with which my paper deals, namely, the nature of osmosis and osmotic pressure. For the same reason I shall not enter upon a discussion of Mr. Whetham's contention that the theory of electrolytic dissociation "rests upon electrical evidence, and by such evidence it must be tried." In this connection it may suffice to refer the reader to the paper which I have prepared at the request of the Faraday Society (see Trans. Faraday Soc., vol. i., also *Phil. Mag.* for February, 1905), in which I have directed attention to the fact that, in creating the theory of electrolytic dissociation, the actual phenomena of electrolysis have played a minor part.

Concerning the remarks made in NATURE of May 17 (p. 54) by Lord Berkeley and Mr. Hartley, I should like to state that, so far as I am aware, the only direct measurements of osmotic pressure which they have made are some preliminary results published in vol. lxxiii. Proc. Roy. Soc., pp. 436–443. In their article in vol. lxxvii. Proc. Roy. Soc., p. 156, I find no direct measurements of osmotic pressure, but simply results of vapour-tension measurements from which osmotic pressures have been computed by means of a modification of a formula of Arrhenius. Of the results given in the two papers mentioned, there is but one case that is comparable, namely, that at concentration 420 grams sugar per litre, the other determinations having been made at different concentrations, so that they are not comparable. Furthermore, all their direct osmotic-pressure measurements were made without stirring, and they are consequently not at all final. I have also in my paper directed attention to the fact that copper ferrocyanide membranes imbedded in porous porcelain are particularly unsuitable for making conclusive direct measurements of osmotic pressure. In these circumstances, it appears that their claim that they have shown experimentally that aqueous solutions of cane sugar give the same osmotic pressure, whether observed directly or deduced indirectly from their vapour-pressures, is not well founded.

As to the computation which Lord Berkeley and Mr. Hartley make concerning one of my experiments, I would state that they assume as a basis for their calculation that the slight amount of sugar found in the outer liquid occurs there because the solution, as such, has passed through the septum. Now this assumption is entirely untenable in the light of the numerous experiments given in my paper illustrating the nature of the osmotic process, and their criticism is consequently worthless.

LOUIS KAHLENBERG.

University of Wisconsin, Madison, June 15.

The Olfactory Sense in Apteryx.

ABOUT a year ago I stated in your columns (May 18, 1905, p. 64) that I was trying to have experiments carried out with the object of ascertaining whether the olfactory sense of the kiwi is perceptibly developed, as one would suppose it to be from certain structural peculiarities in which the bird is unique, viz. the great relative size of the olfactory lobes of the brain and the great size of the olfactory capsule as seen in the skull.

I wrote to the curators of Little Barrier and Resolution Islands, which are reserved as sanctuaries for birds, asking each of them to try certain experiments for me with the object, first, of finding out whether the kiwi exhibited any preference for particular species of earthworm, and, if so, whether any difference in odour, or noticeable difference in colour, was perceptible to them (the curators). I asked whether it was possible to deceive the kiwi in any way by appealing to its sense of smell, while excluding those of sight, hearing, and touch, and formulated a few simple experiments with this end in view.

I recently received a reply from the curator of Resolution Island, in Dusky Sound, who is a careful observer of the habits of birds. Mr. Richard Henry experimented with the larger South Island bird, *Apteryx australis*, usually termed the roa-roa, in opposition to the other South Island bird, the small grey kiwi, *A. oweni*. The former feeds chiefly on earthworms, the latter on grubs of various kinds. Mr. Henry placed a number of earthworms at the bottom of shallow buckets and covered them with four inches of earth. When such a bucket was placed on the ground the roa got quite excited in its hunt through the earth, probing to the bottom for the worms. It must be borne in mind that, according to several good observers, the roa (and kiwi) is practically blind during the day time, and, moreover, the bunch of hair-like feathers at the base of its snout intervenes between its eyes and the ground in this operation, while Mr. Henry states that it makes such a "sniffling noise" that it would be unable to hear a worm, even if the latter made any disturbance in the soil. There remains, therefore, the possibility that the tip of the beak is highly sensitive, and that it finds the worms by touch.

But Mr. Henry writes that the bird seemed readily to be aware whether worms were below the earth without touching the soil, for "when I put down a bucket of earth without worms in it, the bird would not even fly it; but the moment a bucket containing worms (covered with earth) was put down the roa was full of interest in it," and commenced to probe at once with its long beak.

Further, Mr. Henry took several dead worms that had been severely pressed by the spade in digging them up the previous day, and put them at the bottom of a bucket of earth, and at the end of half an hour the roa had not left a scrap of worm behind. He tried the roa with a bucket of earth that had been searched by it on the preceding day, but the bird "would not even look at it." Then he placed a couple of worms under the earth at the bottom of the bucket, and again allowed the roa to have access to it;

this time the bird went to work promptly, "as if he knew the worms were there."

I had suggested, amongst other experiments, that he should rub a living worm over some substance that the kiwi does not usually eat, such as bread, so that it should be flavoured and scented by the earthworm juice, and then conceal it; but he has not yet, apparently, carried out the experiment.

Previously to my request Mr. Henry had experimented with a roa that he had trained to eat meat. He "planted" pieces of meat in drills three or four inches deep, and next day found them gone, "though the ground was not raked over by the bird, but probed where the meat had been hidden. This was in an enclosure whither other creatures had no access. If, when the bird was at rest, though hungry, he threw a piece of meat or an earthworm near it, it seemed at once aware of the presence of food, would wake up and reach in the right direction, touching the ground from time to time with the tip of its beak until it came in contact with the meat.

Although other and more crucial experiments are needed —and these could more readily be made in England (at Tring, for instance) under careful supervision—yet I think the above affords a certain amount of evidence for the existence in Apteryx of a keen sense of smell.

I may add that Resolution Island is quite an unget-at-able place; it is visited about three or four times a year, twice by the Government steamer on its round-trips to supply lighthouses, &c., and occasionally by other vessels at irregular times, so that four or five months may intervene before a reply is received to a letter. For instance, in reply to my letter dated April 30 I only received an answer in October. I once tried to arrange to visit the island, but the uncertainty of getting back to the mainland in any reasonable time was so great that I had to give up the idea. I hope someone in England will undertake further experiments in this direction.

W. B. BENHAM.

Otago University Museum, Dunedin, N.Z., May 6

Molecular Changes in Nickel Steel.

MR. MILNE, chronometer maker in Manchester, has kindly given me permission to send you the following interesting information. About two years ago he made a clock having a rod pendulum of Dr. Guillaume's invar steel (iron nickel alloy). It was carefully adjusted, and was recording time in a most satisfactory manner. Recently the gut of the driving weight tore, and the clock received a shock whereby the rate was altered a few seconds per day. This might be due to some mechanical movement. After re-adjustment had been effected, it was found that the pendulum was undercompensated for changes of temperature, and it appears as if the coefficient of expansion, which was said to be 0·0000008 per 1° C., had increased.

The second case is a watch the balance wheel of which was made of invar steel and brass. In March, 1904, it was rated by the National Physical Laboratory, when it was found that there was no middle temperature error. Now, after two years' working, this error is +1·08 seconds per day, ordinary steel and brass balances having a middle temperature error of about 2½ seconds per day. The details are as follows:—

Temperature	1904 Rate	1906 Rate
40°	+0·6	+1·08
90°	+1 6	+0·36
Mean	+1·1	+0·72
65°	+1·1	+1·80
Middle temp. error .	0·0	1·08

C. E. STROMEYER.

"Lancefield," West Didsbury, June 28.

MANX ARCHÆOLOGY AND NATURAL HISTORY.

IN the year 1886 the House of Keys passed an Act entitled "The Museum and Ancient Monuments Act." I well remember hearing of it, because in the course of that year I visited the Isle of Man for the first time, in order to see some newly discovered Ogam inscriptions. It proved for me the first of a series of visits to the island with the view chiefly of studying Manx Gaelic and Manx folklore. I got to know the island and its people, and noticed among other things the efforts made by two or three men with taste and zeal for archæology and history to interest the Manx people in the relics of antiquity for which the Isle of Man is famous. On one of my rambles, which led me to a public school, I remember being much struck by finding hung on the walls drawings of hatchets, hammers, and other instruments of the ages of Stone and of Bronze, accompanied with letterpress descriptions of them. They were intended to interest the more intelligent of the children in such objects, and especially to help them to recognise them when accidents exposed such treasures to view. It struck me how desirable it was that the same thing should be done in the public schools of this country, but I am not aware that it has ever been done. This example of the Isle of Man is well worth following, but I fear that the present is not a favourable moment for recommending anything so far removed from the burning question of the day. But the present war of creeds and dogmas will, it is to be hoped, be followed by a period of peace when the promoters of education may be allowed to devote more attention to some of the historical aspects of its more secular side.

The first Manx archæologists I came in contact with were Canon Savage and Mr. A. W. Moore, who has since not only become Speaker of the House of Keys, but established the right to be considered the historian of the island. I found them inspired and led by the experienced hand of Prof. Boyd Dawkins. They have been since joined by other and younger men, such as Mr. Kermode, who has made the study of the runic crosses of the island his own. He published a valuable book on them in 1892, but he chose to call it a catalogue of them and of the inscriptions, and now a larger work of his on the same subject is passing through the press, and will contain as illustrations numerous plates and a great number of outline figures. The list of the trustees of the Manx Museum and ancient monuments includes other men of light and leading in the island, such as Mr. Ring, the Attorney-General, not to mention that they have always had the Bishop on that body, and enjoyed the support of successive Governors of the island, including among them the well-known historian, Sir Spencer Walpole. These men have always endeavoured to interest the Manx people in their ancient monuments, and they have succeeded to a great extent, but a great deal still remains to be done in the same direction. The pride of ownership is very strong in a Manxman: perhaps it is in all small nationalities—at any rate, I have noticed it not only in Man, but also in my own country, the Principality of Wales. What may be the explanation I do not know, but a member of a small nationality is a more considerable portion of that nationality than if he belonged to a larger nationality, and perhaps that has something to do with the greater difficulty which he finds in rising to the idea of giving up to the nation anything of which he is the exclusive owner. That is, however, not what I was coming to, but to the fact that, in